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SEPTEMBER 1, 1920

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INDEX TO CONTENTS

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AVIATION AND AERONAUTICAL ENGINEERING

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Vol. IX SEPTEMBER 1, 1920 No. 3

THE safe arrival of four Army De Havilands on Alaskan soil is another triumph of cross continent flying which we may all be proud of. Though the undertaking was accompanied by numerous dangers which could only be surmounted by great skill and daring, the feat has not been accorded the publicity which other flights have received,—whether from the lack of the spectacular or for what reason unknown. Nevertheless, the participants in the flight, both the aviators as well as the ground personnel—for we must not forget the importance of adequate preparation—deserve great credit. They are pioneers who have blazed a trail which will speed up communication with Alaska even as those hardy Americans who established the overland route to the coast.

The linking up of Alaska with the Eastern states is a shining example of the ease with which communication may be established across sparsely settled country by airplane. The time required to build a railroad over approximately the same route would be years and the cost prohibitive. Operation would be expensive and in the absence of a large volume of traffic a losing proposition. While the cost of the necessary chain of landing fields adequately equipped and manned is unknown, it is safe to say that the financial comparison would favor the air route.

Explanation of Soaring Flight

Many observers of soaring birds have hoped to emulate this mode of locomotion which apparently defied the law of the conservation of energy. The problem of bird soaring is a most fascinating one and has been the subject of much speculation and theorizing from time immemorial, but not until recently could it be said that much progress had been made toward its solution. Even now sufficient evidence has not been gathered to state the conclusions with finality, as only a few birds have been studied.

The difficulty has been largely accuracy of observation. Most observers have been without the aid of scientific instruments and their accounts are therefore open to suspicion on many points. It has long been suspected that soaring takes place only in rising columns of air, although there are numerous denials of the dependence of sustentation on these ascendant currents. A number of observers report that light feathers and smoke columns have been observed to show no rising movement in or near the areas in which soaring took place.

Recently more dependable evidence has been submitted on this question. Instruments which measure the air speed and direction have been carried by kites to the location to be studied and observed from ground stations by means of telescopes. In this manner reliable data on the velocity of both wind and bird, and thence their relative velocity, have been obtained. It was found that the wind velocity relative to the bird always had an upward component. The inverse ratio of this component to the horizontal is a measure of the aerodynamical efficiency of the bird.

The measurements taken to date show a lift to drift ratio of 17. This is in agreement with airplane performance although, of course, exceeding the latter by about 100 per cent. This explanation of soaring is much easier to accept than those which state that soaring takes place in still air.

Earlier theories have apparently suffered from a lack of precision in observing velocities.

These experiments, linking up as they do with our present knowledge of aerodynamics, are encouraging, for there is undoubtedly much to be learned from the scientific study of bird flight. The perfection of the ultra-rapid motion picture camera places another powerful tool at the disposal of students in this field, and together with the extended use of the wind tunnel it is hoped that substantial progress will be made before long.

Our Gordon Bennett Challengers

The best wishes of the American aviation world will accompany our challenging team which has just sailed for France in an attempt to bring back to this country the Gordon Bennett Aviation Cup, which American aviators twice succeeded in winning, Glenn H. Curtiss in 1909 and C. T. Weymann in 1911.

As the rules of the Gordon Bennett cup race provide that the race must be won three years in succession before a country can become the permanent holder of the cup, and France won the race in 1912 and in 1913—there having been no competition during the war—this year's race is apparently the last chance our airmen are granted for challenging France's title to permanent ownership of the cup.

Our challenging airplanes, which are illustrated in this issue, represent some very advanced ideas in airplane design, such as cantilever monoplane wings, retractable landing gear, camber change gears—to mention only the most important. Preliminary flight trials have shown these machines to be exceedingly fast. Precise figures as to their performance have not been made public for obvious reasons, but it is believed that the race will be won at a speed of nearly 200 m.p.h. with which expectation in mind our challengers were built.

The question is often asked whether a competition in which high speed is the sole criterion, such as the Gordon Bennett race, produces any practical advance in airplane design. To this the answer, in our opinion, is emphatically in the affirmative. The importance of high speed for military aviation is obvious. But in the commercial application of aircraft the fact is sometimes lost sight of that the principal factor which marks the aircraft as superior to other means of travel is high speed. However, in order that a high rate of speed may be maintained regardless of adverse weather—which does not generally affect the railroad train or the steamship—it is necessary that aircraft possess a maximum speed greatly in excess of that required under normal atmospheric conditions, else their operation will fall behind schedule and make a profitable competition with other means of travel less certain.

It follows that any race which is likely to lead to an increase in the speed of aircraft entirely justifies itself.

The Slow Speed Airplane

By F. H. Norton

The increased use of airplanes for commercial and pleasure purposes will require more landing fields located as closely as possible to the center of the city or town which they serve. The cost of land in such positions prohibits fields of large extent, so that it will be of great importance in the future to have airplanes capable of landing at a very low speed. A machine with a low minimum speed is easier and safer to land, and the process of learning to fly could be greatly shortened. Also, a machine with a low enough minimum speed to remain stationary with respect to the ground when flying in an average wind, would, in a large part, be able to take the place of captive balloons for observation work, and would have the advantage of being able to descend quickly in case of an attack. Altogether, a low minimum speed, if attained without too great a sacrifice of efficiency, is an undisputed advantage.

There are several different methods of lowering the landing speed. Perhaps the most obvious is to decrease the loading of the wings, but as the lift decreases as the square of the velocity, it requires enormous areas to reach a very low speed. A decrease in loading not only decreases the maximum speed and the useful load, but also makes the machine hard to handle on the ground in a heavy wind. The speed can also be lowered by using a high lift wing section, thus decreasing the landing speed as much as 25 per cent below that usually obtained. The high lift sections are, however, quite inefficient and would considerably decrease the speed and climb. A much better method aerodynamically is the use of trailing edge flaps. By pulling these flaps down the lift coefficient can be increased as much as 50 per cent. This method has been actually tried on some foreign machines, but its complications seemed to outweigh its advantages, so that it has not been generally adopted.

Another method of lowering the minimum speed, which, I believe, has not been considered before, consists in placing a large portion of the wings in the slipstream of tractor screws, and then using trailing edge flaps to deflect the air downward. As the velocity in the slipstream is practically constant, whatever the airspeed of the plane, it is evident that the portions of the wings in the slipstream will give a constant lift at all air speeds. Looking at it in another way, instead of the screw pulling the airplane through the air at flying speed, the plane will be stationary or nearly stationary, and the air will be pushed across its own wings at the same speed as before. In order that the machine may remain stationary, not only must the lift balance the weight of the machine, but the drag must also balance the thrust of the screws, in which condition the slipstream will be projected vertically downward.

Before considering further this type of machine, it might be well to consider its most obvious advantages and disadvantages. In the first place this method allows us to obtain a much lower speed than in any other way; in fact there is no reason why the airplane could not be made to even move slowly backwards, with a sufficiently powerful motor. In addition this method, except for adding some transmission weight in a single-motored machine, does not lower the climb or high speed performance. With the flaps as a continuation of the wing, the machine is entirely normal and will behave in every way as the usual type of machine. The first disadvantage is the impossibility of obtaining a subnormal minimum speed when the motor is dead, a time when it is most needed. The flaps alone, however, would give the machine in this condition a much shorter run than usual. Another disadvantage is the lack of longitudinal control in the low speed condition with the usual disposition of the control surfaces.

Lift and Slipstream Deflection

In order to determine the amount of lift and the deflection of the slipstream for a machine of this type, the following model experiments were carried out. A pair of similar R. A. F. 6 aerofoils of 5 in. chord and 12 in. span were mounted as an orthogonal biplane with a 5 in. gap, 1¾ in. of the chord was cut from the trailing edge and hinged so that it could be turned down at any angle. Closely in front of the leading edges was mounted a tractor screw of 9 in. diameter and 11 in. pitch. This tractor was direct-connected to an electric motor running at 5000 r.p.m. A side view of the model is shown in Fig. 1. The lift was measured on a simple lever balance as shown in Fig. 2, and the thrust of the tractor alone was measured by supporting the motor on the end of the same balance (Fig. 3.) The angle of the slipstream was measured by a light thread held in the proper position.

In the first test the model was set up as in Fig. 1 giving a lift of 105 grams and an air deflection of 30 deg. from the tractor axis. It was noticed that the air spread rapidly toward the tips of the wings, so that it is very probable that a greater lift could have been obtained in all cases by using a longer span.

In the second test the conditions were the same except that the wing chord was at 4 deg. from the tractor axis. The lift was 70 grams and the deflection angle was 40 deg. In order to increase the deflection angle, the flaps were pulled down 60 deg. from the original wing chord, which was set at angles of 18, 24 and 37 deg. with the tractor axis, giving respectively slipstream deflections of 62, 67 and 84 deg. The lift was the same in all cases, about 105 grams, as in the first test.

A large flat surface was placed closely under the model in order to represent the ground in landing. It was expected that this would increase the lift, but it actually decreased it about 10 per cent, due probably to the attraction that exists between surfaces along which a fluid is passing.

The thrust of the tractor alone was 140 grams, so that a lift of one half of the thrust can be obtained with the wing chord at 4 deg. to the tractor axis, and a lift of three-quarters the thrust when that angle is 16 deg., so that a lift of three-quarters of the thrust will be assumed hereafter.

Application for Full-Size Machine

The conventional type of tractor machine contains little area in the slipstream, so that it is necessary to modify it by placing a large tractor before the wings on each side of the fuselage, somewhat as in Fig. 4. This arrangement allows a large thrust per hp. and gives wing area in the whole width of the slipstream, but would somewhat increase the weight, although this would be made up to some extent by the increased efficiency of the low speed screws. A few high powered machines have been flown with power loadings of less than 6 lb. hp. so that it is quite possible as far as lift is concerned to construct a machine that would support itself when moving with zero velocity in respect to the air. In order that the wing drag may just balance the thrust, the air must leave the machine vertically downwards. The greatest angle of deflection found in these experiments was 84 deg. with the tractor axis, but in practice the axis would be inclined upwards several degrees so that there would be no difficulty in reaching the desired condition. The slipstream could even be turned forward so that the airplane could be maneuvered slowly backward similarly to the way in which a recent type of marine screw is reversed by placing adjustable blades behind it as shown in Fig. 5.

The thrust of an air screw falls off from a maximum under static conditions, to zero at no slip. In Fig. 6 are plotted three-quarters of the thrust given by 150 hp. with two 16-ft. tractors, 300 hp. and 450 hp., with corresponding sized screws. These will then represent the extra lift gained at each speed by means of the motor power. Curves showing the lift of the wings alone moving through undisturbed air at various speeds are also shown in Fig. 6. These lifts are large because of the downturned trailing edge. A summation of these two sources of lift will, for any given power and area, give the total lift of the plane at any speed.

In Fig. 7 is plotted the lift curve for a training plane, such as the JN-4H, a lift curve for the same machine with the flaps pulled down, and a curve with the lift from the slipstream added. It will be noticed that the landing speed is decreased from 44 to 29 m.p.h. While this is by no

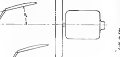


Fig 1

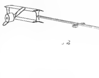


Fig 2


Fig 3

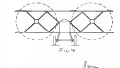


Fig 4


Fig 5


Fig 9

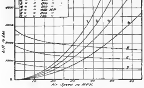


Fig 6

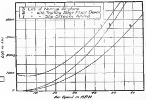


Fig 7

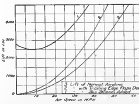


Fig 8

The Slow Speed Airplane

stationary flight, it would greatly decrease the size of the field required for landing

A set of curves is plotted in Fig. 8 for a very high powered machine with 450 hp and 500 sq. ft of area. If the weight of the machine is 3000 lb, which is perfectly practical with the modern air cooled motors, the landing speed of the normal plane, 45 m p h. is reduced by the slipstream lift to 21 m.p.h., a considerable reduction. On the other hand if the weight could be reduced to 2500 lb, the machine would be capable of remaining stationary in the air. Such a low weight could only be reached in a special racing machine with a low factor of safety

The matter of longitudinal control is an important one, as in the slow speed condition practically the whole of the slipstream is deflected downward, so that the tail plane is in the air moving with a very low velocity. In the case of a plane having a speed of 20 m.p.h. the existing tail surface could be somewhat enlarged and used in the present manner, but if the speed falls below this, some other method must be used. The only method that has occurred to the author, is to hinge the body and lower the tail down into the slipstream, as shown in Fig. 9, a method that is very bad mechanically

From the preceding experiments it would seem probable, that without a great departure from the conventional type of machine it would be possible to decrease the landing speed 35 per cent. and by using a very low power loading to obtain stationary flight.

Size and Performance of Rigid Airships

An interesting paper on rigid airship engineering was recently read before the British Institution of Naval Architects by C. I. R. Campbell and H. May. The paper indicates the performance which may be expected from future airships of the rigid type as compared with those already obtained and also deals with points of special interest in design and construction. The paper is as follows

For each of the various parts of the ship the type of loading and the variation of loading with total lift have been considered, with the result that the weights of the parts have been expressed as a function of the total lift, a formula has also been obtained for the total fixed weight of an airship of a given type, including curves of performance for ships similar to R.38 over a large range of total lift. Let N be the ratio of any linear dimension of an airship to the corresponding dimension in the type ship, i. e., a similar airship of equal speed, then it is shown how the weights of the constituent parts of an airship vary with N.

In considering the outer cover it is pointed out that the hull resistance in a modern ship is a high percentage of the total, and also that it cannot be divided into skin friction and form resistance but is closely analogous to skin friction. Hence attention should be paid to improvements in cover. In similar airships the weight varies as N^2. The weight of the gasbags also varies approximately as N^2, as the size of airships increases; the least total weight will probably be obtained by increasing the gasbag supports rather than the bags themselves. With regard to the former there are two systems in use, viz., the "circumferential" and the "diagonal."

In the first system the wires are stretched tightly round the hull inside the longitudinals at intervals of 2 feet. By adjusting the initial tensions, using sliding connections at some longitudinals and fixed ones at others the lift can be taken at any desired part of the circumference. In the second system the wires are arranged in two sets of helices; the main difference between this system and the former is that the gas-bag forces are led away from the center of each frame to the transverse frames. Since the tension is given by PR/L where P is the mean gas pressure per foot and L and R are the length and radius of curvature of the wire respectively, the weight of the wiring varies as N^4. The main longitudinals resist the stresses due to static loading and to the aerodynamic forces. The average loads in the former vary as N^3, causing the weight to vary as N^4, as also does the weight of the intermediate longitudinals introduced to make the form as nearly circular as possible. The main transverse frames and their wiring preserve the sectional form of the ship. The tension in the wires varies as $3V \cdot 1 \cdot R^2$ where A is the sectional area of the wire and $2R$ the mean diameter of the gas-bag. In similar ships for equal stress in the wires A/R^2 must be constant. The weights to be supported vary as N^3 or N^4, and hence the weight of frames and wiring varies as N^4. The same law applies to the intermediate frames hull diagonal wiring and the corridor

The machinery and fuel and oil systems vary approximately as N^2 if the propulsive coefficient be assumed constant, since the resistance varies as N^2. Fins and controls vary as N^3, electrical equipment as N, mooring fittings as N^3, and wireless equipment and control car and instruments as N^0.

Applying these considerations to an airship of R.38 type the following equation is obtained:

$$\frac{\text{Total fixed weight}}{\text{Total lift}} \times 100 = \frac{0\,33}{N^3} + \frac{0\,43}{N^2} + \frac{23\,35}{N} + 8\,06 + 10\,19\,N$$

giving results which show that the percentage is fairly constant over a wide range of total lift, slightly under 40 for ships of 5-15 million cu. ft. capacity, slightly over 40 for ships of under 5 million cu. ft., and 44 for a ship of 2 million cu. ft.

The curves included show (1) the total weight ex-cargo when the ship is equipped for voyages of 50 and 100 hours' duration at 60 knots, (2) actual cargo weights for the same voyages, (3) the speeds at which airships can be run carrying a cargo of 15 per cent of the total lift on voyages as above. The curves show the importance of developing airships in the directions of greater size

N. A. C. A. Reports

EFFECTS OF NATURE OF COOLING SURFACE ON RADIATOR PERFORMANCE. Synopsis of Report No. 87 National Advisory Committee for Aeronautics

This report discusses the effects of roughness, smoothness, and cleanness of cooling surfaces on the performance of aeronautic radiators, as shown by experimental work, with different conditions of surface on (1) heat transfer from a single brass tube and from a radiator, (2) pressure drop in an air stream in a single brass tube and in a radiator, (3) head resistance of a radiator, and (4) flow of air through a radiator. It is shown that while smooth surfaces are better than rough, the surfaces usually found in commercial radiators do not differ enough to show marked effect on performance, *provided the surfaces are kept clean.*

COMPARISON OF U. S. AND BRITISH STANDARD PITOT-STATIC TUBES. Synopsis of Report No. 81, National Advisory Committee for Aeronautics.

British and United States standard Pitot tubes were placed in the reduced section of the Navy Yard 8-ft. tunnel and the heads of each tube were determined for speeds from 20 to 100 m.p.h. In order to be sure that the velocity was the same at the positions at which the Pitot static tubes were placed, after the first run the position of the tubes was reversed and a second run made. It was found that the two tubes checked with one another within the precision of the measurements and gave a true Pitot reading

PROPERTIES OF SPECIAL TYPES OF RADIATORS. Synopsis of Report No. 86, National Advisory Committee for Aeronautics.

The report discusses the general performance characteristics of three special classes of radiators: those with flat plate water tubes, fin and tube types and types that whistle in an air stream. Curves and tables show the performance of representative radiators of each class, and compare the flat plate and whistling types. Empirical equations are given for estimating the performance of flat plate radiators of various dimensions.

The report also contains a brief discussion with curves showing effect of yawing on the properties of a radiator

Copies of these reports may be obtained upon request from the National Advisory Committee for Aeronautics.

Possibilities of a Trans-Pacific Flight *

By Comdr. G. C. Westervelt, (C. C.) U. S. N., and H. B. Sanford

Aeronautical Engineer, Naval Aircraft Factory

The following study of the possibilities of a trans-Pacific flight has been made in the attempt to collect all the available information regarding the conditions upon which such a flight would depend. These flight conditions may be grouped under the following heads:

1. Types of machines available.
2. Distribution and physical conditions of possible landing places.
3. Distances to be flown
4. Meteorological conditions.

The routes to be followed in such a flight would depend almost entirely on the above conditions, for that reason, the discussion of possible routes will be based on a study of these conditions

Types of Machines Available

Four types of machines could be considered as available for such a flight. They are airplanes (land machines), seaplanes of the flying-boat type, non-rigid airships and rigid airships. The non stop flight record for all types of aircraft is held by the rigid airship. It is reported that during the war a German rigid, the L-53, which was dispatched from Bulgaria to carry ammunition and medical supplies for the relief of the troops in German East Africa, was recalled by wireless after reaching Khartoum, in southern Egypt. The total distance flown, in the neighborhood of 4000 nautical miles, was covered in 100 hours, and it is reported that sufficient fuel remained on board for an additional 60 hour flight

The heavier than-air non-stop record is held by the Vickers-Vimy bomber, flown by Alcock and Brown in the flight from Newfoundland to Ireland, a distance of 1680 nautical miles. The seaplane record is held by the NC-4, made in a flight from Newfoundland to the Azores, a distance of approximately 1200 nautical miles. An F-5-L flying boat, tested at Hampton Roads, flew for over 20 hours at an average airspeed of 55 knots, covering in that time something over 1100 nautical miles.

The non-rigid airship record is probably held by the C-5 which in its flight from Montauk Point to St. John's, referred to previously, covered a distance of approximately 1200 nautical miles. This flight was accomplished in 25 hours and 50 minutes. The endurance, as calculated just before getaway at Montauk Point, was 47 hours at a cruising speed of 40 knots, or 1880 nautical miles.

From the records given above, with a choice based on radius of action and reliability, the machines would be classed, in the order of their merit: (1) Rigid airship; (2) non-rigid airship; (3) flying boat. The experience of Hawker and Grieve in their attempted trans-Atlantic flight indicates that a land machine is not safe for long distance flights over water. If a seaplane of the NC or F-5-L type were used, it probably would be found necessary to refuel at sea from a destroyer, unless it were found possible to follow the coast around the North Pacific from the United States to Japan and China

Possible Landing Places

It is possible to find at any of the American cities along the Pacific coast suitable landing places for both land machines and seaplanes of the heavier-than-air type, and for all types of lighter-than-air machines. The cities which most likely would be chosen as starting points for such a flight would be San Francisco and Seattle; these cities are well provided with suitable landing fields and harbors

At Honolulu there are good facilities for landing all types of machines. The large harbor provides a landing for all types of seaplanes, and the parade ground at Fort Schofield provides excellent landing facilities for land machines and lighter-than-air craft.

Landing fields between Honolulu and the Asiatic coast are not numerous, nor of the best for any type of machine. Possible harbors for seaplanes could be found at Jaluit, in the Marshall Islands, at Ponape or at Truk, in the Carolines; at Guam, at Yap, at Cebu and at Manila, in the Philippines; and at Hongkong or at Canton, along the South China coast.

In following the North Pacific coast from Seattle, landings could be made by seaplanes at Sitka, at Kodiak and at Unalaska, in Alaska; at Petropavlovsk, on the Kamchatka peninsula; at Nemuro, Yokohama and Nagasaki, in Japan, and at Shanghai, on the China coast.

Very few, if any, of the places enumerated in the two preceding paragraphs would provide suitable landing fields for land machines. The small islands of the Pacific are in general only coral reefs, and would, in all probability, be rough and unsuitable for landing purposes. Those of the islands which are of volcanic formation are simply high, rocky projections which would be entirely unsuited for landings. At a few points it is probable that landings could be made, particularly at Guam and at Manila, where there are parade grounds maintained by the United States forces stationed there. On some of the islands, it would be possible to erect mooring towers for lighter-than-air craft, but the work involved would be very great. Along the North Pacific coast the greater part of the land is such that it would be difficult to find a field large enough and sufficiently smooth for the landing of a land type machine.

Distances to Be Flown

The shortest distance in a direct line from any point on the west coast of the United States, exclusive of Alaska, to the nearest point of any commercial importance on the Asiatic coast is the distance from Astoria, Oregon, to Yokohama, Japan, a distance of approximately 4200 nautical miles. The minimum distance at any point between the American continent and the Asiatic continent is between the northwest extremity of Alaska and the most northeasterly point of Siberia, a distance of approximately 25 miles. Because of location and of weather conditions, a flight across this short space would hardly be considered.

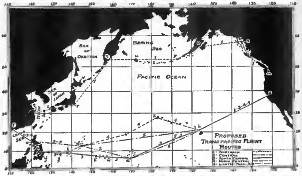
For comparison with distances across the Pacific, the distance covered by Alcock and Brown in their trans-Atlantic flight was 1680 nautical miles, the record for any type of heavier-than-air machine, the distance flown by the NC-4 from Newfoundland to the Azores was 1200 nautical miles, the record for seaplanes. It should be noted however, that the range of action of the NC-4 as equipped for this flight was approximately 1400 nautical miles. The distance from San Francisco to Honolulu, which is the nearest landing point to the Pacific coast, is 2090 nautical miles, an increase of 410 miles over the greatest distance covered thus far by a heavier-than-air machine in a non-stop flight. The distance from Honolulu to the Asiatic coast at Hongkong is 4900 nautical miles, and from Honolulu to Yokohama, is approximately 3400 miles. The distance from Sitka across the North Pacific to the Alaskan Peninsula is approximately 1600 nautical miles, and from the Alaskan Peninsula across Bering Sea to Kamchatka, approximately 1260 miles.

These figures show that the proposed flight across the Pacific will involve non-stop runs which greatly exceed any which thus far have been accomplished in any type of heavier-than-air machine, unless the northern route is followed. The total distance from Mineola to East Fortune, Scotland, flown by the R-34, was approximately 2700 nautical miles. This exceeds by 30 per cent the distance from San Francisco to Honolulu. The flight from Honolulu to Hongkong of 4900 miles could be broken up into three shorter flights, landings being made at Jaluit and at Guam, and if desirable, at Manila. The flight of the German Zeppelin referred to previously would indicate that this type of machine could cover any non-stop run necessary in the trans-Pacific flight.

Meteorological Conditions

The meteorological conditions which must be considered in

* Excerpt from a paper read before the United States Naval Institute



(a) San Francisco. (b) Honolulu. (c) Jaluit. (d) Guam. (e) Manila.
(f) Honghong. (g) Johnston Island. (h) Truk or Hogulo. (i) Yap (j) Cebu.
(k) Midway Islands. (l) Wake Islands. (m) Seattle. (n) Sitka. (o) Kodiak.
(p) Unalaska. (q) Petropavlovsk. (r) Yokohama. (s) Nagasaki. (t) Shanghai.
(u) Attu Islands. (v) Nemuro. (w) Ponape.

a study of the possibilities of this flight are winds, fogs, temperatures, calms and storms. All must be favorable before a flight is attempted.

The prevailing winds are due to several more or less constant conditions of atmospheric pressure which prevail over certain portions of the Pacific These are the North Pacific high, the South American high, the Asiatic high and the Aleutian low Of these, the North Pacific high has the greatest effect in the regions which probably would be covered in this flight The others tend, in certain portions of the ocean, to modify the conditions which result from the North Pacific high

The North Pacific high is confined in position to limits between 31° and 45° north latitude and 135° and 150° west longitude The direction of the winds around this region of high pressure is anti-cyclonic, or clockwise.

The South American high is practically fixed in position at latitude 30° south and longitude 100° west (approximate) The direction of the winds around this region is cyclonic, or counter-clockwise.

The Asiatic high prevails off the Asiatic coast from October to April It extends along the coast from Shanghai to north Korea, and eastward as far as 155° east longitude. It disappears in the spring and reappears in October The direction of the winds around this region is anti-cyclonic, or clockwise.

The Aleutian low centers over Bering Sea, the Gulf of Alaska and the Alaskan Peninsula, and prevails from September to June The direction of the winds around this region is cyclonic, or counter-clockwise

Due to these conditions of atmospheric pressure, certain prevailing winds are found These are the northeast trades, the southeast trades, the westerly winds, and the summer and winter monsoons.

The northeast trades are practically continuous throughout the year and extend from a few miles off the coast of the United States almost to the Philippine Islands. Their limits move north and south, between the equator and the 36th parallel, north latitude, following the change in position of the North Pacific high. In winter and spring they merge with the winter monsoons along the south Asiatic coast. For a distance of approximately 200 miles off the American coast, the winds may be variable, but beyond that limit the trades prevail.

The southeast trades cover the Pacific between the position of the South American high, as given above, and the equator. Their limits are practically fixed Between the regions covered by the northeast trades and the southeast trades is a narrow zone, centering at about 10° north latitude, in which the winds are variable, northeast, east or southeast

Due to the North Pacific high and the Aleutian low there are strong westerly winds covering that portion of the Pacific between Japan and Canada. These winds center between 45° and 50° north latitude, and prevail during all months of the year except June, July and August

Due to the Asiatic high, the winds prevailing along the Asiatic coast during the winter months, known as the winter monsoons, are from the northeast These winds often blow with storm force, and, in general, cause thick, rainy weather, and make navigation along the coast difficult. During May, June, July and August, the winter monsoons disappear and the summer monsoons take their place. These winds are in general from the southeast, and are not as strong or as constant as the winter monsoons.

The south Asiatic coast and the Philippine Islands are subject to frequent and severe typhoons—sudden tropical storms of great violence originating in the Pacific Islands near the equator, and traveling west, northwest and northeast across the Philippines and the China coast. The number and severity of these storms is a maximum during the months of July, August and September, when they may be four to six per month, and a minimum during February, during which month less than five have been reported during the last twenty-two years.

During the months from December to July inclusive, there may be severe storms originating along the Asiatic coast and moving in a generally northeasterly direction to the Aleutian Islands, the Alaskan and Canadian coasts. These storms may be of from six to eight days duration.

The Central Pacific is practically free from severe storms travelling along extended tracks, but is subject to severe local storms which may occur during almost any month of the year.

A study of fog conditions shows that throughout the year fog prevail along the west coast of America from San Francisco to Seattle and Sitka, the number of days of fog during the month varying from 5 to 40 per cent, depending on the season of the year. From Sitka to the Alaskan Peninsula and the Aleutian Islands, fog prevails during all months of the year except October, November and December. Across the North Pacific from the Aleutian Islands to Kamchatka, and south to Japan, fogs prevail during the months of June, July August and September, from 30 to 50 per cent of the days of these months are with fog.

The most southerly mid-ocean limit of the region of fog is the Midway Islands, 28° north latitude, where during the month of May, 15 per cent of the days are with fog. The portions of the ocean between the 28th parallel, north latitude, and the equator are free from fog throughout the year, except along the American coast.

The temperatures which prevail over the Pacific Ocean are such that they would cause no difficulties to aerial travel, except in the extreme north, in the neighborhood of Alaska and Kamchatka.

Discussion of Possible Routes

After a study of the landing places which could be used in the trans-Pacific flight, routes have been laid out which show the greatest possibilities for this flight. These routes are shown on the accompanying sketch.

Route 1—the Northern Route—follows a path from Seattle to Sitka, thence to Kodiak, to Unalaska, to Petropavlovsk, to Yokohama, to Nagasaki and finally to Shanghai. The total distance covered in this flight would be 5415 nautical miles and the distances to be covered between landing places work out as follows —

	Nautical Miles
Seattle to Sitka	765
Sitka to Kodiak	600
Kodiak to Unalaska	540
Unalaska to Petropavlovsk	[illegible]
Petropavlovsk to Yokohama	[illegible]
Yokohama to Nagasaki	510
Nagasaki to Shanghai	420

A study of the distance to be flown shows that each section of the route is well within the range of flight of several of the types of aircraft already constructed The longest sections are from Unalaska to Petropavlovsk and from the latter place to Yokohama. If it appears desirable these may be divided into shorter sections. Between Unalaska and Petropavlovsk is the island of Attu, which if used as a landing place would divide the 1260 mile route into two sections, one of 765 nautical miles, between Unalaska and Attu and the other, 525 nautical miles, between Attu and Petropavlovsk The section of the route from Petropavlovsk to Yokohama could be divided by making a landing at Nemuro, in northern Japan This would make two sections, one from Petropavlovsk to Nemuro, of 825 nautical miles, and the other, from Nemuro to Yokohama, of 605 nautical miles.

In studying the meteorological conditions for Route 1 it appears that for a flight from the American coast to the Asiatic coast head winds would be encountered along the section of the route from Unalaska to Petropavlovsk throughout the months from January to April inclusive, and from October to December inclusive During the remaining months of the year the winds are variable, with varying high percentages of days with fog. These two conditions, and the extreme low temperatures encountered at Petropavlovsk from November to May, would tend to make this route very undesirable for any type of machine which has thus far been constructed.

Route 2—the Central Route—is from San Francisco to Honolulu, thence to Jaluit, to Guam, to Manila and to Hongkong The total distance to be flown in following this route is 7690 nautical miles. The distances between landing places are as follows:—

	Nautical Miles
San Francisco to Honolulu	2090
Honolulu to Jaluit	2150
Jaluit to Guam	1490
Guam to Manila	1330
Manila to Hongkong	630

It will be noted that the distance to be flown from San Francisco to Honolulu is 2090 nautical miles, and from Honolulu to Jaluit, 2150 nautical miles, exceeding the distance covered thus far in any non-stop flight with heavier-than-air machines. The only machines which have covered greater distances in non-stop flights are the rigid airships of the types of the German L.49 and L.53, and the British R-33

The portions of this route from San Francisco to Guam are within the region covered by the northeast trades, which prevail, with very few exceptions, during the entire year These winds vary in strength from 15 to 24 nautical miles per hour, and could be counted on to give material aid in the flight from San Francisco to Jaluit, in which sections the course followed is almost directly in line with the direction of the northeast trades. In the sections from Jaluit to Manila the course would be across the direction of the winds, while from Manila to Hongkong the winds are variable

This route is practically free from fog at all periods of the year, except for the region of San Francisco, where fogs extend a few hundred miles out to sea.

Route 3—the South Central Route—follows very closely Route 2 Starting from San Francisco the course is laid to Honolulu, thence to Johnstone Islands, to Jaluit, to Truk in the Caroline Islands, to Yap in the Pelew group, to Cebu in the Philippines, to Manila and to Hongkong The total distance covered in this flight is 7899 nautical miles, an increase of 209 miles over that of Route 2. The advantage of this route in comparison with Route 2 is that the distances to be covered in non-stop flight are made much less, because of making use of a greater number of landing places. The only lap which is not shortened is that from San Francisco to Honolulu (2090 nautical miles.)

If provisions could be made for the refueling of seaplanes at sea it would be possible for flying boats of the NC type to cover the distance from San Francisco to Honolulu with one refueling

Meteorological conditions which prevail on Route 3 vary very little from those which have been described for Route 2.

Route 4—the North Central Route—deviates quite considerably in the central portion from Routes 2 and 3 As with the latter two the first section would be from San Francisco to Honolulu, from the latter place the route would be to the Midway Islands, thence to Wake, to Guam, to Yap, to Cebu, to Manila and Hongkong The total distance covered following this route would be 7811 nautical miles, with following distances between landing places —

	Nautical Miles
San Francisco to Honolulu	2090
Honolulu to Midway Islands	1140
Midway Islands to Wake	1050
Wake to Guam	[illegible]
Guam to Yap	457
Yap to Cebu	964
Cebu to Manila	310
Manila to Hongkong	630

The only advantages of this route in comparison with Route 2 are a decrease in the distances to be covered in non-stop flight, and the fact that all landing places except Hongkong are under control of the United States Government

Route 5—the Lighter-than-Air Route—at the present time available for lighter-than-air craft only, would be from San Francisco to Honolulu, thence to Guam, to Manila and to Hongkong The total distance covered would be 7440 nautical miles, and the longest non-stop flight would be from Honolulu to Guam, a distance of 3400 nautical miles. Meteorological conditions would vary little from those previously described for Route 2.

Summary

The study of the information available regarding the five routes which have been outlined for the trans-Pacific flight shows certain characteristics which should be considered in choosing a route to be followed

First.—The Northern Route, while offering the advantages of short distances to be covered in non-stop flight, is subject to the disadvantages of extreme cold during months from October to May and subject to extreme fog conditions during the months from May to September inclusive. These two conditions make an attempt at flight following this course inadvisable.

Second.—Route 2, because of the long distances to be covered in non-stop flight, is unsuited for any type of heavier-than-air machine which has been thus far constructed. It might be possible to accomplish flight following this route if provisions were made for refueling machines of the NC type at sea. Flight along this route could be accomplished by a rigid airship of the R-34 type.

Third.—Routes 3 and 4 offer advantages of shorter non-stop flights, as compared with Route 2. It should be noted, however, that there is no way of decreasing the distance from San Francisco to Honolulu, and any machine capable of flight between these points could cover the distances necessary for the flight between all other landing places in Route 2. Route 4 has the advantage of all landing places, except Hongkong, being under United States Government control. It might be desirable to make a combination of Routes 2 and 4, the courses being laid from San Francisco to Honolulu, to Midway, to Wake, to Guam, to Manila and to Hongkong.

Fourth.—Route 5, due to the long non-stop flights to be accomplished, would be suitable for large lighter-than-air craft only. Several rigid airships are now in use in Europe which could cover these distances. This route has the advantage of all landing points, except Hongkong, being under United States control. It might be feasible to make this a main route, with emergency mooring towers located at Midway Islands, at Yap (if this island becomes United States property) and at Cebu. The station at the Midway Islands might also be used as a landing point on flights from Honolulu to Yokohama, a total distance of 3400 nautical miles.

A study of the weather conditions along Route 2 shows that during the months of January, February and March the east trades are practically constant in velocity over the entire course from San Francisco to Guam. This is a period of the year when typhoons are a minimum, so that the course from Guam to Manila and from Manila to Hongkong would be practically free from the influence of these storms. These months, and particularly the month of February, would be the most suitable for attempting a flight following this course. This flight could easily be accomplished with a rigid airship of the R-34 type, and it is probable that it could be accomplished by a non-rigid airship of the C-5 type, if especially equipped for the flight. The following calculations, based upon information obtained from an article published by Commander Hunsaker in AVIATION of September 1, 1919, show the possibilities of the C-5 type non-rigid airship in accomplishing this flight.

The endurance of the C-5 as equipped for the flight from Montauk to Newfoundland was 47 hours, at a cruising speed of 40 nautical miles per hour. This gives a cruising range of 1880 nautical miles. This range is somewhat less than the distance to be covered between San Francisco and Honolulu, and between Honolulu and Jaluit. If, however, the assistance due to the northeast trades, which have a constant velocity through the month of February of 20 nautical miles per hour, be counted upon, we find that the cruising range would be increased from 1880 to 2820 nautical miles. This gives a cruising range more than sufficient to accomplish the flights mentioned above. The following calculations have been made to determine the time necessary for the flight for each section of this route. It is found in each case that the time of flight is much less than the endurance of the machine, because of the assistance of the northeast trades.

Time, San Francisco to Honolulu	34.8 hours.
Time, Honolulu to Jaluit	35.5 hours.
Time, Jaluit to Guam	26.4 hours.
Time, Guam to Manila	24.7 hours.
Time, Manila to Hongkong	17.3 hours.
Total flying time, San Francisco to Hongkong	138.7 hours.

In case the fuel supply should be exhausted, because of adverse winds, or for any other reason, it would be possible for the airship to summon a destroyer by wireless, and refuel and replenish water ballast and gas from the destroyer at sea.

In calculating the times listed above, allowances have been made in all cases for both the direction and the velocity of the winds that would prevail over the different sections of the course. These, of course, would vary during different days of the month, but it is probable that the calculated time would not be more than 10 per cent in error.

It should be noted that the wind velocity used in the above calculation is that which prevails at water level, as shown by the monthly pilot charts for the North Pacific Ocean, published by the Hydrographic Office.

Conclusions

The conclusion reached through the study of the possible routes as described previously is that there is no type of heavier-than-air machine in use at the present time which could accomplish the trans-Pacific flight, without refueling at sea, unless Route 1 were followed. Flight over this course does not appear advisable, because of adverse weather conditions. Temperature conditions are favorable along all routes except Route 1. Fog might delay flight along the Central Routes only at San Francisco.

Lighter-than-air craft could accomplish the flight following Routes 2 or 5, and the month in which weather conditions would be best for this flight would be the month of February. It would not be wise to attempt flights with lighter-than air machines during the months of June, July, August and September because of the frequency and severity of typhoons likely to be encountered between Guam and Manila, and between Manila and Hongkong. A lighter-than-air craft of the type of the R-34, having cruised over Route 2 or Route 5 during the month of February, could, by going inland a short distance from Hongkong, work its way up the China coast to Shanghai, and then across to Japan. Following a course practically along the 45th parallel, north latitude, it would find, during the month of March, westerly winds which would make it possible for the ship to accomplish a non-stop flight from Japan to Seattle or Vancouver. The distance to be covered in this flight is approximately 4200 nautical miles. This distance is approximately the same as that covered by the German rigid airship mentioned previously, in the flight from Bulgaria to Khartoum and back, without regassing or refueling. By going to higher altitudes to avoid storms, flights as just outlined could probably be accomplished by lighter-than-air craft at any season of the year.

Book Review

AERIAL TRANSPORT. By G. Holt Thomas (259 pp.) Hodder and Stoughton Ltd., London. Illustrated with four maps and sixty four full page photographs.

The author of this book, through his connection with a prominent British company engaged in the commercial operation of airplanes, is well prepared to discuss the subject in hand. Although Mr Holt is financially interested in the success of commercial aviation it cannot be said that he has adopted too optimistic an attitude as to its present and future. The treatment is not technical and the arguments are not supported by many figures. This is not surprising at this stage of development, when transportation by air may be said to be in its infancy. Mr Holt undoubtedly has at his service much cost information which aerial transportation companies, extant and proposed, would be glad to take advantage of, but which he has refrained from disclosing. The chapter nominally devoted to this subject is entirely devoid of any new figures.

The book as a whole is an attempt to bring home the advantages of this new means of transportation to the public, especially the business man, and to encourage its use. The entire argument hinges on experience with the London-Paris service to which many allusions are made throughout the book. In fact it is the story of this service interspersed with a few short general discussions. To one who has looked forward to a technical treatise or a source of detailed data the work is a great disappointment. There are no details given of the proper organization of an air line, of the airdrome design and requirements, its personnel and operation. The difficulties encountered in thick weather are discussed, but outside of the use of meteorological forecasts there are few suggestions made as to the solution of the problem.

Adapting an F-5L Flying Boat to Air Transport

By Paul G. Zimmermann, M. E.
Engineer in Charge, Aeromarine Plane and Motor Co.

The problem of disposing of surplus material confronted all departments of the government as the war ended. The Army and Navy Air Services were particularly interested in disposing to the best possible advantage the millions of dollars worth of airplanes and motors delivered or under contract. This was especially true as the state of the art was and is changing so rapidly as to make material obsolete in a short time.

The great question of how to make use of this material confronted everyone. The smaller training planes offered no very great problem. It was only necessary to strip them of their armament and notify commercial selling organizations that they were available for sale. This also applied to the small flying boats and hydros, but when it came to the big flying boats it was a different question. These boats were offered at a third of their cost, yet no bidder seemed interested. Accordingly the Navy entered into an agreement with the Aeromarine Plane & Motor Co., to make over the largest type into a first class passenger cruiser. The F-5L was chosen because it was the best machine of its type, having been designed by the Navy after the various shortcomings of the H-16 (a copy of the English F-3, designed originally by Lieut. Comdr. John Porte of the British Air Force) had been determined.

The bottom, found weak on the H 16, was strengthened on the F-5L, in fact the whole hull was generally recalculated and made stronger; the wings were increased in area and the tail construction was improved. The raised cabin was removed and suitable windshields substituted. The whole machine was thoroughly gone over and any weakness discovered was corrected. For this reason the F-5L was chosen as a base from which to build the Aeromarine Commercial Cruiser.

The first boat was shipped from Philadelphia and arrived in Keyport about May 1, when work was immediately started, plans for the conversion having previously been prepared by Aeromarine engineers.

The first impression of one acquainted with the F-5L in specting the converted machine is that the hull bears no similarity to the original. Upon closer examination it is found to be the same from the chines down. In order to afford an opportunity for the pilot or mechanic to reach and quickly adjust a motor and at the same time to give the passengers the maximum comfort and vision, the pilot's position is changed from the front to the back between the wing beams, where a comfortable operating cabin is provided.

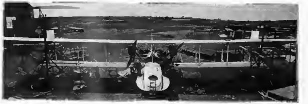
The original streamlining over the hull front and rear has been removed, and a substantial linen-covered wooden roof substituted. To afford head room, and at the same time offer maximum bracing effect, a raised tunnel is located in the center of the roof. The roof carlins or stiffening members are laminated ash and spruce. As these are bolted to the chines with brass clips, a substantial tie between chines is affected and the whole structure is made exceedingly rigid.

The front cabin, as well as the rear, is lined with mahogany veneer. It seats six people while the rear holds five. Comfortable leather cushioned wicker chairs accommodate the passengers. Automobile carpet covers the floors, while shades made of rich fabric protect the windows when needed. Cigar lighters and vanity cases are conveniently located on the wall. Dome lights are used when night flying is done. The former gunners' cockpit is used as an observatory while in flight and by the crew in picking up a mooring after landing. The anchor is carried in this compartment which is partitioned from the cabin by a sliding door. To the rear of the front cabin, another door leads to the mechanics' compartment. A door to the rear of this admits one to the cozy rear cabin.

While in flight and closed the cabins are sound-proof and deaden much of the motor noise, permitting one to talk with the same facility as in a railroad coach passing another train. The celluloid windows (18 in. in diameter) absorb noise and are largely responsible for this advantage.

Fuel is supplied for four hours' flight at full throttle, about six hours at cruising speed. The entire gasoline system, with the exception of the tanks, was changed from that on the F-5L. The same tanks are used, but cut down so as to hold but 240 gal. The pumps and piping were removed and an anemometer driven gear pump substituted. A rubber gasoline hose replaces the copper tubing of the old installation. These changes in the gasoline system afford a saving in weight and make a much simpler and more easily operated and reliable system.

A complete system of ventilation is in use. This not only keeps the air in the cabins cool and fresh, but carries off all gasoline and other fumes. Side ventilators in the tunnel roof of the front cabin scoop in and eject the air, all except the two front ones being ejectors. Ejectors on either side of the hull under the wing attachment suck the air from the bottom of the hull in the gasoline compartment, thus relieving it of the heavy fumes. The rear cabin ventilators are one ejector and two intakes.



VIEW SHOWING SCAFFOLDING FOR WING ASSEMBLY, ILLUSTRATING METHOD OF HANDLING

Roof Cabling Looking from the Front

The faults of the Liberty motors were carefully investigated and the only real trouble was found to be the possible fracture of the timing gears. Accordingly a heavier set of gears was ordered and installed in each motor. The lower case was dropped and the whole inside carefully washed free of chips. With these precautions and the change of oil pressure from thirty-five to fifty pounds the motors are giving excellent service.

At the time of writing the Aeromarine Cruiser has had forty hours in the air. The boat has given great satisfaction. Two new F-5L's are now being reconstructed. Owing to the fact that the first model proved so satisfactory the two new cruisers will be practically identical with the model just described.

Steam Motors for Aircraft

Germany and England have produced experimental steam motors for aircraft use that have at least shown promise in their trials and it is high time that the United States produce the finished product, especially considering that we already lead in this type of motor as applied to automobiles. In order that this motor may be of value however it must not only equal existing internal combustion engine performance to be acceptable but must supersede that performance. It is hoped that inventors and those who are technically familiar with steam engine performance will contribute their experience to the solution of this problem.

As late as 1913 the consideration of steam for powering airplanes was met with candid disfavor, but owing to the rapid progress made in aeronautics since that time it is believed that the time is ripe to make such overtures as would meet with reasoning. Simultaneously the developments in steam engines and boilers have been so progressive as to suggest that the impracticabilities formerly pointed out may have been almost entirely eradicated. Below one hundred horsepower there would seem to be little demand for the steam aeronautical motor but for power over that it is felt that there is a large field of utility. As multi-motored planes become more frequent the limitations imposed formerly by the amount of fuel and water will not seriously impede the radius of action, but this point must be watched carefully in the design of such a motor even now and the maximum efficiency procured. The question of weight of motor and boiler is today not of such vital importance even as is this problem of fuel and water, for the design and progress in the former two essentials have come to a point of easy adaptability.

Naturally high pressure steam will have to be used, and the efficiency of such an engine is most marked in its non-condensing designs to which airplane uses will be undoubtedly limited. In that case the steam consumption will have to be reduced to the minimum and high steam pressure carried. This will involve a problem of securing the same efficiency as is obtained in engines operating against low steam pressures. With ordinary steam engines there is a great difference of temperature in the cylinders which causes additional cylinder condensation. Multiple cylinders or multiple expansion engines have heretofore cared for this somewhat, but condensation in this fashion offsets the benefits of high pressure. The problem of cylinder condensation however has been satisfactorily solved so that high pressure steam can be used in one cylinder without loss due to the wide range of temperature.

This is accomplished by allowing the exhaust steam to remain in the cylinder near the head where it is superheated by the jacket in the head and then when compression increases the temperature of the steam in the cylinder the walls are simultaneously heated to a temperature above that of the entering steam so that there is no initial condensation. This status obtains throughout expansion also. The single acting steam engine is particularly adapted for this purpose as a type primarily due to the fact that it eliminates stuffing boxes and simplifies this problem of expansion in that there is a gradual difference in temperature between the bottom and the top of the cylinder. Simplification is also achieved in this design in the valve motion and obviation of the reversal of strains, both of which become serious problems at high speed.

Probably the most advantageous arrangement for a steam aeronautical motor will be found to be that of three cylinders set at 120 deg. in the one plane. In this design a good turning torque is obtained with a minimum of base while the valve motion is very simple. The latter consists of one cam directly on the main driving shaft driving the valve push rods. Exhaust is cared for in allowing the piston to uncover a port at the bottom of the stroke. A variable shut-off is accomplishable by tapering the cam. While this design offers considerable head resistance it seems to be more reliable than others and with the boiler will compare favorably with other designs and motors.

An engine designed to develop 200 hp. at 900 r.p.m. on 450 lb. to 500 lb. of steam pressure ought not to weigh more than 400 lb. and the condenser with it ought not to weight more than 100 lb. Such an engine would require about 1¼ lb. of liquid fuel per horse power hour and 14 lb. of water. Condenser efficiency is so high today together with the conditions of flying which are favorable that at least 80 per cent of the water ought to be reclaimed.

The boiler, which will be considered in a later article, must overcome all the problems of pressure decrease which include the rising boiling point, increasing pressure per square inch, and so forth. In general it is felt that the reliability of this means of propulsion will appeal heavily and with the advent of all-metal airplanes is sufficiently attractive to warrant trial although it should be undertaken by someone who is familiar with aeronautics as well as a specialist in steam engineering.—*Air Service News Letter.*

Aeromarine Model 75 Afloat

An Improved A. P. Kite Balloon

By J. F. Boyle
Chief Engineer of the Airship Manufacturing Co.

This article is intended to describe the latest development in Kite Balloons, namely the A. P. Kite designed by Dr. Eng. Prassone, director of the Establishment of Aeronautical Construction, and by Maj. del Gemio Avorio, head of the Aeronautical Division of the Italian army, and redesigned according to American practice. Two of these kite balloons were imported from Italy and tested by the Army and Navy. Three were built for the Navy, after changing the designs slightly. The first of these kites was tested at the Naval Air Station, Pensacola, Fla., recently.

There have been several types of kite balloons in use by the different governments, all of them emanating from the original Parseval-Siegsfeld or Drachen designed and built by the Germans several years ago.

The idea of the kite balloon was to get a balloon which would rise in the air on a cable anchored to a winch and ride there steadily in winds varying from a calm up to sixty miles an hour or more.

Before kite balloons were invented an attempt was made to use spherical balloons with a special rigging for attaching to the winch cable. The spherical was not eminently successful because it was not stable. It would not head in to the wind because there was nothing to make it do so. It simply twirled around as it pleased and pitched and dived at will. These difficulties led to the invention of the Drachen.

Caquot Kite Balloon

The Drachen was a cylindrical gas bag with an air ballonet and with a suspension band extending around it just below the equator line. Rope bridles were attached to the suspension band and then to the cable winch. The basket was hung on smaller rope bridles independent of the cable suspension. An empennage was fitted to the rear of the gas bag. This empennage extended from midway of the belly of the balloon around underneath to just above the center line of the rear hemisphere. The front end was open and there was a smaller outlet at the top end. The wind entered the front end and flowed through out the smaller opening at the top end. This kept the empennage inflated and naturally kept the nose of the kite headed into the wind, just as an umbrella held at the handle will point its opening into the wind and eventually turn inside out. The ballonet was filled with air through an air scoop at the forward end. The air in the ballonet was allowed to escape through an opening into the empennage. This helped keep the empennage inflated and prevented an excess of pressure in the ballonet.

The Drachen performed better than the anchored spherical but it soon became evident that it could be improved. The main trouble with it was that it kited too much, that is, it nosed up and the great wind pressure on the belly of it caused too great a pull on the cable. It was hard to haul in or let out. It also rolled considerably and dived and handled badly at low altitudes.

The Caquot replaced the Drachen. This kite was designed by Captain Caquot of the French Army. The bag is more streamline than that of the Drachen. It has a fineness ratio of about three. There are three empennages located at intervals of 120 deg. on the circumference. They are somewhat different in shape from the original Drachen empennages. Instead of being open in the front only, the bottom one, or rudder, has an air scoop at its lowest point through which air is taken in. The air passes up to the side empennages or fins through air ducts. The ballonet is forward in order to obtain the proper balance. The suspension system is similar to the Drachen, there being rope bridles. Two types of Caquot were designed, the M and the R. The M is shorter and fatter. The R is longer and thinner. They act similarly.

The Caquot was a great improvement over the Drachen. It rode very steadily with less kiting, that is, it rode more nearly horizontal. It could stand much higher winds because of its streamline shape and because of the lessening of the kiting effect. It did not roll because the fins held it steady. It did handle rather badly sometimes at low altitudes and was very apt to nose dive. When being towed it rode up and down quite a bit, causing an uncomfortable movement of the basket. The suspension system was not entirely satisfactory and required a great deal of rigging.

The A. P. seems to be an improvement over the Caquot, for many reasons which will be described later.

The gas bag is nearly spherical in shape. It is actually ellipsoidal. The ballonet is forward and is similar to the Caquot ballonet. There is an air cone attached to the rear of the gas bag on the outside. This air cone ends in an inflating appendix. The three empennages are attached partly to the air cone and partly to the gas bag. They are distributed at 120 deg. angles around the tail, the lower fin or rudder being vertical. The empennages are very much larger than the Caquot or Drachen empennages. Air is introduced into the ballonet and lower empennage through an air scoop similar to the Caquot. From the lower empennage the air flows into the air cone and from there through openings into the upper empennages. There is an automatic air release valve on top of the air cone. This allows the air to escape thus preventing excess pressure in the empennages. The suspension band is of catenary type with 12 points of suspension. The suspension band will be described later. The mooring band is also of the catenary type, with 15 mooring points. There are transverse bands running from each suspension point upward

to each mooring point, then over the top of the balloon. This constitutes really a net over the balloon and distributes the load of suspension and mooring over a great area. The suspension of the mooring cable is by 12 hemp ropes from each of the 12 suspension points in the catenary band to a concentration ring to which is attached a cable junction piece. The suspension of the basket is by eight hemp ropes from eight of the suspension points of the catenary band to eight toggles on the basket. There is no basket bar.

The following are details of construction, which are interesting, being different from other kites:

The rip panel is a new type. It is in the shape of an inverted V and stradles the nose of the gas bag. It rips from the outside, the rip starting at the apex of the V. This means that the rip panel can be ripped in one half the time that it would be if it were in one long panel. The rip cord is brought around the nose of the bag on the outside and is supported by breakable cord patches.

Valve Arrangement—The valve is mounted on the side just above the equator line. The original Italian kite had one valve. On the opposite side of the bag from the valve there was an anchor patch. A valve wire extended from the valve across through the balloon to the anchor patch. From the middle of this cross was a vertical rope extending downward to the ballonet. When the ballonet was deflated and pressed against the lower part of the envelope, the valve opened automatically. We put a valve in both sides of the envelope and connected the two valves with the cross wire. The valve line was adjusted by a shortening or lengthening of the vertical rope which extended through the ballonet from a gas tight arrangement and out through a sleeve in the bottom of the envelope. A valve line is led out through the side of the bag above the ballonet seam and then down to the basket.

The mooring harness consists of 15 mooring patches on the upper side of the bag. These mooring patches are connected by catenary bands. There are mooring patches of webbing extending over the top of the balloon to the corresponding mooring patch on the opposite side. This produces the effect of a net over the bag thereby distributing the load.

The suspension band is made up of 1/4 in. extra flexible cable worked into a fabric band and the whole cemented, stitched and taped to the bag around the lower part. This band is in the shape of a catenary curve with 12 suspension points. At each suspension point a hollow ring is worked onto the cable into a fabric and duck patch. From these points the suspension ropes are taken off. From each one of the suspension points a webbing strip extends upward to the mooring patch above it and thence over the top of the balloon so that the load of the suspension is carried both into the catenary cable and over the top of the balloon in the webbing strips.

A true catenary band will distribute the load at each point along the catenary to the entire surface of the balloon. On the original Italian A. P. balloon this suspension cable was worked right into the envelope itself, that is, the envelope was cut in the shape of a catenary curve and sewed around the cable. This was changed as described above, the cable being built into a fabric band and the whole attached to the bag without cutting the bag. The ends of the suspension cable are anchored by large patches to the balloon. The inflating appendix is in the rear of the gas bag. The ballonet deflating appendix is in the forward end of the ballonet.

An interesting arrangement is found on the ballonet. This consists of a long sealed fabric tube, 6 ft. long and 5 in. in diameter. It is attached to the ballonet and communicates with the gas chamber of the gas bag. It is allowed to extend out through the bottom of the envelope through a sleeve. The idea of this is that during inflation, this tube is extended and becomes inflated when the bag is full of gas. It is really a sight valve. When this tube begins to swell it is time to stop inflating. In other words the ballonet is touching the bottom of the gas bag. This tube is then rolled up and tacked away inside of the bag and the sleeve tied off.

The cone attached to the rear of the gas bag is built of light two-ply fabric on the upper portion and single ply fabric in the lower part. It has inflating appendix in the rear end which is tied off during the flight.

The empennages are single ply fabric and attached to the gas bag and cone in the regular way, that is, by cementing and stitching. The internal rope rigging of the empennages

Avorio-Prassone Kite-Balloon

is done away with and in its place are diaphragms extending across the empennages, serving to keep their shape. The original diaphragms were silk. We substituted cotton sheeting. The diaphragms have holes cut in them to allow passage of air. These diaphragms seem to be a distinct improvement over the old rope rigging, both as to the effect of keeping the shape and greater simplicity of construction.

There are no air ducts connecting the empennages. The bottom empennage receives air through an air scoop at its lowest point. This air flows into the air cone through a one way fabric valve and from this into the upper empennages through several holes cut in the air cone between it and the empennages.

There is a fabric release valve on top of the air cone. This is simply a fabric hood weighed down with several discs of fabric cemented together. This disc flops down covering up the outlet hole under the hood. When the pressure becomes great enough it lifts this disc and the excess pressure flows out.

Suspension.—The winch suspension concentrates in two groups or ropes, six ropes from each side of the balloon. These two groups of six ropes are spliced into two solid iron rings which in turn are welded into one iron ring which takes the short section of cable to which is attached the mooring cable junction piece. The ropes are Italian hemp 3/4 in. in diameter. Each rope has an adjusting block which permits lengthening and shortening of the rope in order to procure equal tension in all ropes. Leather is sewn on to the ropes where they pass through the rings. This prevents chafing.

The basket is suspended from eight ropes, four on each side of the balloon. These ropes are attached directly to the basket toggles, omitting the usual basket bar which is employed in the Caquot. The front and rear basket ropes criss-cross from one side of the balloon to the opposite side of the basket. This prevents adverse swinging of the basket. Two middle basket ropes criss-cross, the front rope to the rear of the basket and the rear ropes to the front of the basket. This

prevents the basket from swinging forward and backward. The only trouble with this arrangement is that the ropes chafe on each other. This can be prevented by applying leather to the ropes where they rub. These ropes are Italian hemp 1/2 in. in diameter. Each rope is fitted with an adjusting block.

The mooring ropes are spliced into the mooring points. There are eye splices in the ends for attaching the secondary mooring ropes and the third set of ropes which are handling ropes. This makes a very long handling rope and allows the balloon to be let up very high so as to clear obstacles in maneuvering. The maneuvering ropes are cotton.

The original Italian basket was a square one with eight toggles straddling the four corners. The baskets used in these Navy kites were regular Caquot baskets, elliptical in shape with only six toggles. The middle toggles had to be fitted with an arrangement to take two ropes each. The bag is equipped with the usual manometer.

Trials.—The trials of this American built A. P. Kite were held at the Naval Air Station, Pensacola, Fla. The kite was first put through the usual tests for permeability, lift, valve adjustment and basket rigging. The bag held 43,000 cu. ft. The Caquots hold 37,000 cu. ft. The tail cone and empennages were inflated with air before ascending. This is the usual practice. The tail cone and empennages would inflate themselves as the balloon rose, but it is best to inflate them on the ground with a blower because the balloon handles better with the empennages and tail cones inflated. It was put through a series of tests which included towing from a ship. In this test a Caquot R was towed from another ship. Two Eagle boats were used and comparative results were obtained. Winds up to 50 m.p.h. were encountered. The A. P. rode steadier and had a great deal more lift than the R. It towed somewhat harder than the R, due to its fatter envelope. In high winds the fins fluttered somewhat. This was due apparently to the release valve on top of the cone being too light. This of course, can be remedied by weighting the valve down a bit.

The following is a summary of the advantages of this type of balloon over previous types.

The first and one of the biggest advantages of this balloon over other balloons for sea work is that the basket is swung very close to the concentration point of the winch mooring ropes. The distance between the basket and the junction piece is only about 8 ft. Consequently, when the balloon is hauled down to the deck of the ship the aviator is able to step from the basket directly on to the deck. This is the only type of balloon with which it is possible to do this. In all other types the basket is swung very far away from the junction piece and the aviator must be transferred from the basket to the deck by a block and falls and bos'n's chair. Usually, and especially in rough weather, the aviator gets wet. This advantage alone is enough to warrant changing over to this type of kite for Navy work. It is possible to swing the basket on this kite close to the junction piece because of the shape of the balloon, the bag being nearly spherical, all the concentrated weights, that is, the basket and the winch suspensions, are bound to be close together. Other kites are long in comparison to their width and consequently the basket must be swung rearward in order to balance the load of the mooring cable which is forward.

The balloon being almost spherical in shape has greater lift for a given weight of envelope than the Caquot. This allows a more compact balloon.

The balloon has the inherent stability of a spherical. It is slower to respond to wind changes, consequently it doesn't hop around as much as other balloons. It rides very steady.

The basket has very slight motion, due both to the stability of the balloon and to the method of crossing the basket ropes.

The suspension is very simple, much simpler than the Caquot. There is practically no rigging necessary since all of the winch suspension ropes are centered at one point and are never changed except for slight adjustments in the take-up blocks. The basket ropes need practically no adjusting after the initial adjustment, since the basket hangs always in the same place.

There is more air space and fin surface, consequently a better shape of gas bag is possible.

Maneuvering is easier due to the compactness of the balloon and the spherical shape of it.

The balloon does not nose dive. The central sand bag attachment permits of loading the winch suspension rope concentration point with a great number of bags with a consequent increased ease in handling. It should ride better as a spherical in case it broke away.

There are certain disadvantages, such as chafing of crossed ropes, harder towing, and danger of tearing the empennages due to their great size.

In conclusion, it seems that the A. P. Kite should replace the Caquot, at least for sea work. The results of the tests have been very gratifying. It is, however, very clear that some changes in design must be made. These changes in design will be decided upon by a conference of various authorities and a comparison of notes from the testing field and from the factory where they were constructed. The changes will be made with a view toward cheaper and easier construction, since some of the construction was very difficult according to the Italian idea and altogether too expensive. Better results in towing will be aimed at since the balloon has considerable head resistance. It may be that the balloon can be decreased in size because it appears to have too great a lift for the heights at which balloons are used at sea. If it were reduced in size there would be a proportionate reduction in size of accessories and suspension ropes with a consequent lessening of weight. The empennages will have to be strengthened probably by using two-ply fabric and cross-bracing between them, and the bag will have to be installed. Chafing of ropes on each other and on the bag will have to be prevented. Whatever changes are made it is safe to assume that the original principal of design will be adhered to and that the changes will result in bringing forth a very efficient and satisfactory kite balloon.

Manufacturers Association Seeks Data

The Manufacturers Aircraft Association in the preparation of the 1921 issue of the Aircraft Year Book is gathering data regarding civil and commercial activities in the United States. All companies are requested to send to the association at 501 Fifth Ave., New York, answers to the following questions which will be incorporated in the record of the progress of aeronautics during the year 1920.

1 A. Name of Company, address and officers. B. Date and purpose of organization. 2. How many planes operating. (Designate type and make.) 3. A. Location of air terminals. B. Do you own them? C. Describe terminal facilities (hangars, shops, supply stations, etc.). D. What are your immediate needs? E. Has your city a municipal landing field? 4. What help are you getting from municipal and other authorities? 5. A. Total number of passengers carried. B. Total mileage flown. C. Pounds of freight carried. D. What are your rates per passenger for 10 or 15 minutes? Per person per mile for inter-city flights? Per pound per mile for express or freight? Is your business profitable? 6. *Confidential Information*—A. How many crashes have you had? B. Cause and effect? C. How many forced landings? Note (Our purpose in assembling this information is to get an approximate idea of safety in actual commercial flight and your report will be held in confidence. 7. Describe territory in which you are operating. 8. Is there any competition in your vicinity? 9. Are you in favor of a separate Federal bureau or department of aeronautics? 10. Send best photographs available.—Write complete description, names of individuals, dates, etc., written on back.

Balloon Race Shifted to Chicago

The national balloon race, September 11, for which there are fifteen entries, including three from the Army and one from the Navy, has been transferred from Indianapolis to White City Park, Chicago. The international balloon race scheduled for October 23 also has been transferred to the Chicago field. Of eleven entries in the international event, eight are from foreign countries. The international race was held in White City Park twelve years ago.

Our Gordon Bennett Cup Challengers

THE DAYTON-WRIGHT CHALLENGER FOR THE GORDON BENNETT CUP (250 HP. HALL-SCOTT LIBERTY SIX ENGINE

Three American challengers have been entered for the Gordon Bennett Aviation Cup race which will take place between Sept 27 and Oct. 3, at Etampes, France. While complete technical details of the challenging machines are naturally withheld until after the race, the following information is available

The Texas Wildcat, built by the Curtiss Aeroplane and Motor Corp., which is illustrated on the front cover, is a monoplane fitted with the Curtiss C 12 400 hp. engine. The wings are trussed to the landing gear by rigid struts. The landing gear does not incorporate any shock absorbing device

The challenger built by the Dayton Wright Division of General Motors Corp., is also a monoplane, but the wings are devoid of any external bracing, being built as cantilevers so as to be self-supporting. The wings are provided with a camber changing gear by means of which their curvature can be increased for the take-off and landing, and flattened out for high speed. This is effected by a displacement of the entering edge. The power plant is a Hall Scott Liberty Six engine developing 250 hp., which is cooled by a nose radiator. The landing gear is retractable into apertures provided for this purpose in the fuselage

The Army challenger, built by the Engineering Division of the Air Service, is a modification of the V. C. P. pursuit machine. The wings are braced by laminated I type interplane struts and the power plant is the new Packard 500 hp. engine.

It may be noted that in all three challengers the streamlining has been carried to a very high degree of perfection

The following pilots have been designated to fly the challengers: Curtiss, Clarence Coombs, Roland Rohlfs (alternate), Dayton-Wright, Howard Rinehart, Army Air Service, Capt. R. W. Schroeder, Capt C C Moseley (alternate).

THE U. S. ARMY CHALLENGER FOR THE GORDON BENNETT CUP (500 HP. PACKARD ENGINE)
Photo International

The London Aero Exhibition

By John Jay Ide

The sixth aeronautical exhibition to be held in London was housed in Olympia from July 9th to 20th inclusive. It was sponsored by The Society of British Aircraft Constructors. Although interesting from a technical point of view the show proved a failure from the standpoint of attendance. The most obvious reason for this lies in the apparent apathy of the British public toward aeronautics at present. Other causes ascribed were insufficient advertising and the relatively high price of admission (2 shillings and 6 pence). Also it must be remembered that Olympia is far removed from the center of London, although this fact proved no bar to the thousands who swarmed to the automobile show there last Winter

The exhibition was termed "International," but of the two non-British exhibitors one—Henry Potez—showed an empty stand and the other—Louis Breguet—had on view merely a couple of models. The list of aircraft actually shown included Austin, Avro, Beardmore, Blackburn, Bristol, B. A. T., Centaur, Fairey, Martinsyde, Handley Page, Short, Sopwith, Supermarine, Vickers and Westland. The engines exhibited were the Armstrong-Siddeley, Beardmore, Bristol (formerly Cosmos), Gwynne (B. R. 2 and Clerget), Napier, Rolls-Royce, Sunbeam and Zeitlin.

Around the outer edge of the hall were the stands devoted to propellers, radiators, models, accessories and materials. In the Annex was arranged an historical exhibit loaned by The Aircraft Disposal Co. which, it will be remembered, bought from the British Government their entire surplus stock of aviation material. The exhibit comprised fourteen representative types of airplanes and flying boats used during the war and a number of engines and accessories.

In the gallery there was in many respects the most interesting part of the whole show: the Air Ministry exhibit. It was divided into various section. The Aeronautical Inspection Department showed the methods of testing and inspecting all material entering into the construction of aircraft and the tests to destruction of the complete aircraft themselves. The methods of testing engine parts and accessories were likewise shown. The Airship Section included complete cars of various types of airships from the S. S. Z. to the R-37 now being constructed at Bedford. Various smaller parts such as rigid airship girders, valves, rudders and fittings were shown as were models of airships and airship stations. The Medical Sections exhibited electrically heated clothing, oxygen breathing apparatus, safety appliances and instruments used for the examination of aviators. The National Physical Laboratory showed a model of one of their wind tunnel and a water tank, both in operation. Finally, the Instrument Section had a very comprehensive collection of navigational and wireless instruments

The accompanying table gives the principal characteristics of all the aircraft exhibited. It will be sufficient therefore to dwell briefly upon the comparatively few machines of outstanding interest.

The Blackburn "Swift" is a torpedo carrying ship airplane built as a private venture by the firm that produced the "Blackburd" torpedo carrier. The "Swift" will be bought by the Air Ministry and undoubtedly the progressive policy of the Blackburn Company will be rewarded by additional orders. The flotation and torpedo gear was not shown. The fuselage of great size for a single seater is of curious form, the top section rising sharply from the engine to the cockpit and then descending to the tail. The reason for placing the pilot so high is apparently to give him maximum visibility. The whole of the central unit, comprising the engine mounting, center part of fuselage, center section of wings and landing chassis, is a steel framework which under normal circumstances should never need truing up

The undercarriage is well arranged to allow a clear space below the fuselage for torpedo dropping. Below each of the front spar center section struts is a telescopic rubber sprung chassis strut supported by a hinged strut running backward from its base to the base of each rear spar center section strut. On each side tubes run from the bottom of the fuselage toward the telescopic strut, being terminated by horizontal tubes forming the wheel spindles. The wings are attached to the center section with dihedral and forward stagger. When folded the wings incline upward owing to the inward rake of the center section struts.

The Fairey XXI is a two-seater fighter twin float seaplane with the usual Fairey variable camber wings of the folding type. The trailing edges are operated by a wheel mounted in the pilot's cockpit. The outer portions of the trailing edges are separate units and can move independently of the rest as ordinary ailerons. A novel point is the interconnection of the control wheel for varying the camber with that for trimming the tail plane. In order to give a free field of fire aft there is an vertical fin above the tail plane.

The fuselage is built up of three separate parts, the nose-piece carrying the engine, the tail piece and, between them, a central unit of steel including the top and bottom center wing spars, the center section struts and all wing and undercarriage fittings. The nose and tail pieces are attached to the central unit by bolts. Other points of interest on the Fairey XXI include a device whereby the pilot's seat can be raised six inches to improve the visibility at the expense of comfort. The amphibian gear was not fitted at the show, nor were two of the four guns which the machine is designed to take.

The Bristol "Pullman" triplane was by far the largest machine in the show. Fitted with four Liberty 400 hp. engines it has a speed of 125 m.p.h. The general features can be grasped from the accompanying illustration. There are two passenger cabins connected by a passage with the gasoline tanks on either side. The total number of passengers carried is fourteen, in addition to the pilot and engineer who sit in the extreme bow. The various controls for the four engines are very compactly arranged. The instruments are sunk in a black instrument board above the windows in the bow. The undercarriage consists of an arrangement of four wheels with radius rods and shock absorbers inside streamline housings. The two wheels on each side are interconnected by a deformable parallelogram of steel tubes allowing a slight fore and aft movement in addition to vertical travel

The Austin "Whippet, although of only 21 ft. 6 in. span, has folding wings with a very neat locking device. Truing up is reduced to a minimum by the suppression of lift and landing wires and the substitution of steel tubes, sloping outward from the lower wing roots to the top of the interplane struts which are of the N type. In the fuselage also wire bracing is replaced by diagonal steel tubes.

The Martinsyde "Semi-Quaver" single seater biplane is one of the fastest machines in the world having made a speed of 161 m.p.h. over 1 kilometer officially timed. On July 24 it won the Aerial Derby making 153 m.p.h.

The "Semi-Quaver" has no center wing section. The upper wings meet at the apex of a pair of inverted Vees forming a cebane, the lower wings spring from wing roots built onto the fuselage.

The specifications of the engines exhibited are given in a table herewith. There are two engines however that merit special mention: the Bristol "Jupiter" and the Zeitlin.

The Bristol Co. has taken over the patent rights of the air-cooled radial engines formerly made by the Cosmos Co. The "Jupiter" 450 hp. 9 cylinder engine is the most interesting of these. One of its features is the induction system. The induction chamber contains an aluminum spiral casting constituting a three start spiral. There are three carburetors, each feeding a separate convolution, leading to three cylinders appropriately spaced. Thus, if one cylinder or carburetor gives trouble, six cylinders at least will remain in normal action.

The Zeitlin is a 220 hp. 9 cylinder rotary single valve engine, which has a working stroke of 181 mm., exhaust and compression strokes of 203.6 mm. and a suction stroke of 226 mm. On the suction stroke induction ports at the bottom of the stroke are uncovered. The variable stroke is secured by mounting the big-end of each connecting rod upon an eccentric

which is caused to rotate upon the crankpin in the same direction as the engine itself and at half the engine speed, thus producing the effect of a crank of variable throw By means of an altitude control the exhaust valve can be opened during a portion of the compression stroke, thus expelling the excess air at low altitudes.

ENGINES EXHIBITED AT THE OLYMPIA SHOW

Make	Name	Type	Cooling	No Cyl	Bore (in)	Stroke (in)	B HP /R P M	Wt Dry (lb)
Armstrong-Siddeley	——	Opposed	Air	2	5	5	45 /1500	170
Armstrong-Siddeley	——	Radial	Air	7	5	5	150 /1500	380
Armstrong-Siddeley		Radial	Air	14	5	5	300 /1500	650
Armstrong-Siddeley	Puma	Vertical	Water	6	5 7	7 5	246 /1400	636
Armstrong-Siddeley	Tiger	V	Water	12	5 5	7 1	500 /1500	1000
Beardmore	——	Vertical	Water	6	5 57	6 87	180 /1400	600
Bristol	Lucifer	Radial	Air	3	5 75	6 25	100 /1600	300
Bristol	Jupiter I	Radial	Air	9	5 75	7 5	450 /1850	658
Bristol	Jupiter II	Radial	Air	9	5 75	7 5	450 /1850†	865
Gwynne	B R 2	Rotary	Air	9	5 5	7 08	280 /1300	499
Gwynne	Clerget 9Z	Rotary	Air	9	4 12	5 5	100 /1300	250
Gwynne	Clerget 9 BF	Rotary	Air	9	4 71	6 75	146 /1250	357
Gwynne	Clerget 11 E B	Rotary	Air	11	4 71	7 47	230 /1600	516
Hispano-Suiza	——	V	Water	8	5 5	5 89	300 /1856	*736
Napier	Lion	V	Water	12	5 5	5 12	450 /2000	840
Rolls-Royce	Hawk	Vertical	Water	6	4	6	100 /1500	405
Rolls-Royce	Falcon	V	Water	12	4	5 75	280 /2250†	685
Rolls-Royce	Eagle	V	Water	12	4 5	6 5	360 /1800†	900
Rolls-Royce	Condor	V	Water	12	5 5	7 5	600 /1750†	1300
Sunbeam	Dyak	Vertical	Water	6	4 72	5 12	100 /1200	388
Sunbeam	Arab	V	Water	8	4 72	5 12	200 /1600	517
Sunbeam	Maori	V	Water	12	4 33	5 1	200 /2000†	845
Sunbeam	Matabele	V	Water	12	4 8	6 3	420 /2000†	1000
Sunbeam	Semi Sikh	Vertical	Water	6	7 08	8 27	425 /1400†	
Sunbeam	Sikh	V	Water	12	7 08	8 27	850 /1400†	1852
Zeitlin	——	Rotary	Air	8	5 5	7 12 8 8 88	220	

† Geared * Weight with water

Air Service Mechanics School

When it comes to training men in mechanics few civil institutions can boast of a record for turning out efficient men equal to that of the Air Service Mechanics School at Kelly Field.

The fiscal year of 1921 finds the Air Service Mechanics School Training Department, with four hundred and ten students enrolled. These students have been drawn from all parts of the Air Service Some are recruits while others are members of different tactical organizations. The number of students enrolled in each course are as follows

Course for airplane mechanicians	154
Course for engine mechanicians .	167
Course for auto repairmen	20
Army paperwork and stenography	16
Aircraft armament	31
Awaiting instruction or in hospital, etc.	22
Total	410

In addition to the above there is organized a course for electricians, one for instrument repairmen, blacksmiths and machinists. Plans of instruction are completely drawn up, hangar space ready but the complete list of equipment has not yet been delivered. The course for parachute repairmen has graduated a number of students but at present no classes are receiving instruction in this work. However, the instructors in this course are preparing material for the next class, testing parachutes and repairing chutes for pilots. They are also constructing a double harness which was recently presented at McCook Field. This harness does not hamper the jumper in his movements as the two harnesses do It was impossible for him to get out of this harness unassisted. With this new jumping harness a jumper can release himself at any time in case of landing on a building, in the water, or other inconvenient places.

The standard length of the courses in this school, with few exceptions, is four and one half months. No students will be accepted for instruction who do not have at least one year yet to serve after the date of graduation.

Much has been said about restricting the training of enlisted men to practical work. The fact, gained through experience during the war and up to the present time, is that a certain amount of theoretical knowledge is essential in order to apply practical knowledge. By this it is not meant that a student has to undergo a course of instruction in theory and formulae but means that he must understand the elementary principles of the theory of carburetion before he can properly diagnose carburetion troubles He must also understand the elementary principles of electricity to properly keep up the ignition system. In this school, the practical and theoretical work go hand in hand but the first hand is always the practical.

The Advanced Training Division consists of two weeks of supervised practical work on actual flying planes This work is under the direction of a very competent officer The instructors are carefully chosen men and the finished grade of the student is determined largely by the work accomplished by this course The work on all service planes such as De Havillands, S E -5's, Fokkers, Spads, Curtiss, Le Peres and Sopwith Camels is given. Directions on the proper method of warming up the motor or to properly prepare the plane for long cross country flights are learned

The men are given problems in rigging to work out and these problems are not completed until planes which are used fly properly. In addition to this each man is given one or more flights and while in the air their attention is called to the reading of the various aeronautical instruments and the behavior under various conditions. There are many wrinkles in the upkeep and maintenance of the plane which the student picks up during the period of his work in this department. The average pilot can tell you how to service a plane but to do this correctly and accurately takes practice At present there are eighty-eight students in this division, thirty-eight of whom have just been graduated. Fourteen of these men have completed the course as airplane mechanicians and twenty-four have completed the course for engine mechanics. Every week classes of both airplane mechanicians and engine mechanics are entered by the progressive system The importance of training can not be overestimated for here the practical worth of a man is determined.

Aircraft Exhibited at the Olympia Show

	Make	Name or Series No.	Type	No. of Passengers	No. of Eng plan	Make of Engine	H P	Maximum Span	Overall Length	Overall Height	Climb (ft./min)	Weight empty (lbs)	Weight loaded (lbs)	Maximum Speed m p.h	Wing Area (sq ft.)	Range in hours at m p.h	Loading lbs. per h p	Loading lbs per sq ft
1	Austin	Whippet	Biplane‡	0	1	Anzani	45 50	21′ 0″	16′ 3″	7′ 0″	5000/9	580	810	95	134	2/60	16.2	6
2	Avro	Baby	Biplane	0	1	Green	35	25′ 0″	16′ 3″	7′ 0″	5000/15	655	870	80	176.5	4½/70	21 7	4.8
3	Avro	547A	Triplane	4	1	Siddeley "Puma"	240	37′ 0″	08′ 10″	14′ 9″	5000/7 0	2 060	3,250	100	458	4½/65	13 7	6.6
4	Avro	548	Triplane	2	1	Renault	80	36′ 0″	28′ 5″	10′ 5″	5000/15.5	1 338	1 960	60	320	2¾/65	24.3	5.6
5	Beardmore	W.B 2	Biplane	1	1	Beardmore	160	35′ 0″	27′ 7″	10′ 11″	5000/16	1 751	2 518	157	354	4/100	15 7	7.1
6	Blackburn	Swift	Biplane‡	0	1	Napier "Lion"	450	46′ 0″	35′ 0″	12′ 0″	850/1	3,100	6,000	113	700	4	13.3	8 6
7	Bristol	Pullman	Triplane	14	4	Liberty	400	81′ 0″	52′ 0″	20′ 0″	5000/5	11 000	17 700	125	1905	4½/100	11 1	9 8
8	Bristol	Tourer	Biplane	2	1	Siddeley "Puma"	240	39′ 5″	30′ 1″	9′ 0″	10000/13	1,900	3,100	115	405	7	16.5	7 7
9	D.A.T.	Commercial Mark 1	Biplane	4	1	Rolls Royce "Eagle VIII"	350	46′ 0″	34′ 6″	11′ 3″	5000/4	3,200	4,500	108	580	5/111	16	7 7
10	D.A.T.	Bantam	Biplane	0	1	A.B.C. Wasp II	200	25′ 0″	18′ 5″	6′ 9″	15000/18 6	953	1,618	150	185	3½	8 1	8 76
11	D.A.T.	Crow	Monoplane	0	1	A.B.C. Gnat	40	30′ 0″	14′ 0″	5′ 0″	——	220	450	60	70	2	11.2	6 0
12	Centaur	4 B	Seaplane (Bi)	2	1	Anzani	100	30′ 0″	27′ 3″	11′ 4″	1900/2 6	1,310	1,900	75	280	6	18 7	4 8
13	Fairey	XXI	Seaplane (Bi)‡	1	1	Napier Lion	450	40′ 0″	30′ 0″	11′ 6″	——	—	—	130	—		0.0	11 0
14	Martinsyde	A Mark II	Biplane	4	1	Hispano-Suiza	300	43′ 4″	29′ 1½″	10′ 0″	——	*3,400	4,000	115	510	5½/100	13 0	7.7
15	Martinsyde	F 4A	Biplane	1	1	Hispano-Suiza	300	32′ 9″	25′ 6″	8′ 10″	——	—	2,300	142	328	6½/110	7.5	7 0
16	Martinsyde	Semi-quaver	Biplane	0	1	Hispano-Suiza	300	20′ 2″	19′ 3″	7′ 3″	——	—	2,055	160	307	—	10.8	6.7
17	Handley Page	W.8	Biplane‡	15	2	Napier Lion	450	75′ 0″	60′ 0″	17′ 0″	——	†8,000	12,000	112	1500	6½	13.3	8 0
18	Short	Shrimp	Seaplane (Bi.)‡	3	1	Beardmore	160	44′ 9″	29′ 0″	12′ 6″	10000/35	2,095	3,100	82	500	3	15 5	6 8
19	Short	Silver Streak	Biplane	0	1	Siddeley "Puma"	240	37′ 6″	26′ 0″	10′ 0″	10000/11	1,655	2,070	120	370	5/90	10.2	7.2
20	Sopwith	Dove	Biplane	2	1	Le Rhone	80	25′ 0″	19′ 0″	9′ 6″	5000/7 6	950	1,430	100	218	2/100	17 8	6 7
21	Sopwith	Gnu	Biplane	2	1	Le Rhone	110	38′ 0″	25′ 6″	10′ 0″	5000/7 75	1,350	2,100	93	354	2½/90	19 0	6.1
22	Sopwith	Antelope	Biplane	2	1	Hispano-Suiza	180	46′ 0″	30′ 0″	11′ 0″	5000/7 5	2,100	3,200	100	550	4/100	18 0	5 4
23	Supermarine	Sea King	Flying Boat (Biplane)	0	1	Beardmore	160	30′ 5″	24′ 0″	10′ 5″	10000/20	*2,250	2,600	103	384	—	15 6	6.9
24	Supermarine	Channel	Flying Boat (Biplane)‡	5	1	Beardmore	260	50′ 3″	30′ 0″	13′ 0″	——	*3,400	—	65	452	4	61 0	7.5
25	Vickers	Vimy Commercial	Biplane	10	2	Rolls Royce "Eagle VIII"	360	67′ 0″	42′ 8″	15′ 3″	6000/17	7 600	12 600	100	1300	5	17 8	6.8
26	Vickers	Viking	Amphibian (Biplane)	4	1	Rolls-Royce "Eagle VIII"	360	46′ 0″	32′ 0″	13′ 0″	6000/11	2,740	4,545	110	595	4	12 6	9
27	Westland	Limousine	Biplane	6	1	Hispano-Suiza	300	38′ 2″	33′ 6″	10′ 9″	——	*3,120	3,800	115	435	4½/90	10 0	8.7

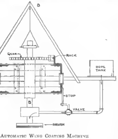
* With fuel † With crew and fuel ‡ Folding wings

Coating Airplane Wings Mechanically

By Geo. Hopp

Present methods of coating airplane wings consist in painting on the dope by hand. Several coats are applied to the fabric this way, all are supposed well worked into the yarn. Of these, the first coat is the most important, the second, third and fourth are next in importance. It is obvious that varying results will occur. Studies made on coating of paper, where the most precise instruments applied the coat, showed marked variation in the quantity of material used, so that it is obvious that the hand application will show, comparatively speaking, large variations.

In view of the fact thet hand application of dope is influenced by the skill and strength of the workman and his resistance to dope fumes, not only will several wings show variation in ounces of dope per square foot but the same wing will show these variations in a large degree. Lakes and dry spots on wings can be easily seen during the course of the painting as



Automatic Wing Coating Machine

well as brush marks. This lack of uniformity means loss of materials as well as loss of efficiency from the point of view both of tautness and of skin friction.

To overcome this a method was devised whereby the dope was sprayed on the wings. The liquid is forced through a nozzel in a fine spray on to the wings. The danger and lack of success attending this method resulted from the fact that the liquid was not rubbed into the fabric, but formed a mere superficial coat. In addition, fine bubbles were introduced into the coat. The net product was a wing with a weak film, lacking the requisite tautness and elasticity.

The author devised a coating machine, based on a study of the hand motions employed in coating a plane. Briefly, a brush is moved back and forth on a given surface, and if desired, with a slow rotating movement, to force the liquid among the fibres of the yarn; pressure is applied at the same time, simulating the pressure used in hand-painting, dope is fed directly through the brush or immediately in front of it. The liquid is automatically turned on as the brush starts its forward movement but is automatically turned off on its return journey. When one complete movement has occurred, the whole carriage is advanced by a screw movement a distance that will permit the brush to just join the finished surface. The diagram illustrates the most important principles of the mechanism.

Through the skill of Mr DeVecchi, the whole device was worked out on a laboratory scale and proved successful. In the diagram, *A* is moved back and forth by means of the chain and sprocket, *B* is a shaft holding the brush, giving it a rotating motion, if desired and permitting an up and down motion to conform to the curvatures of the plane. On *B* proper weight adjustments are made, thereby obtaining a uniform pressure of the brush on the fabric and the forcing of the dope into the yarn, or if light pressure is used, just giving a slight surface coat.

By this device one man is needed to control the machine, to observe that the wing is properly placed and that the carriage does not travel too far beyond the wing. By means of the framework *D*, the brush may be raised from the wing whenever desired.

Uniformity of surface, economy of material and proper impregnation per square foot can be obtained.

In addition, the solvents themselves may be recovered. When dope was formally costing about five dollars per gallon and with at least three dollers of every five evaporating into this air and with the scarcity of solvents, the importance and possibilities of this device aroused great interest among the experts to whom it was shown. By properly enclosing the machine in an airtight room and directing it from without, the volatile solvents could be led out through washers, recovered and again used.

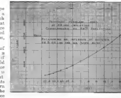
In conclusion, it may be soid that when large scale production again takes place in the airplane industry, this device or the improved principles upon which it is based, will not be altogether absent from the dope-room.

Loads for Airplane Tires

The Goodyear Tire & Rubber Company recommend the following loads for various size tires:

SIZE	PRESSURE	LOAD
26 x 3	60 to 60	600 lb
26 x 4	20 to 60	1000 lb
750 x 125	60 to 60	1500 lb.
800 x 150	50 to 60	1900 lb.
900 x 200	60 to 60	3160 lb

The plot attached shows still other sizes from 2½ to 15 in. The loads are conservative and do not give high bearing pressures on the ground. They may be used therefore on landing fields which have fairly soft surfaces.



Loads for Airplane Tires